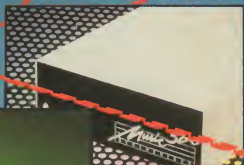


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Econet Action

Gordon Taylor

Econet is a Local Area Network (LAN) for the inter-connection of microcomputers. Acorn announced it at Compec in November 1980, so it pre-dates the Beeb. The first examples used Acorn Atom as stations and Acorn "System" series machines as file servers. Nowadays the stations are usually Beebs and the file servers are also based on Beebs.

The station machines need to be fitted with the Econet interface hardware and Network Filing System (NFS) ROM (now combined with the Disc Filing System -- DFS -- as the DNFS), at a cost of some £75 including VAT. Each station must be given a unique station address. This can be from 1 to 254 and is set by links inside each machine.

Econet is basically linear or bus-type (as opposed to radial, tree or ring), but can have connecting cables not longer than 2m going to single stations. The minimum network would consist of a cable with a clockbox and terminators. Econet cables can be 500m or more long and this much costs about £300 to £350. Shorter networks can use a lower cost cable.

The clockbox provides a frequency standard (of 100 to 200kHz) and the terminators are necessary to prevent "reflections" from the ends of the cable, which would corrupt the signals. The clockbox, two terminators and three double socket boxes are sold together as a Start Up kit for £115, including VAT. This minimum configuration would provide communication between stations -- which is as much as, or more than, some other networks provide at best.

With Econet however, it is usual to have central filing (from a "file server") and printing (from a "print server") as well. Any number of file servers or print servers may be used on one network. The file servers have been based on various Acorn computers over the years and three "levels" are now offered -- as detailed below.

The individual stations can also have their own "local" filing systems (which may be cassette or disc). Those with discs need

Felsted School provides the perfect environment for a study of Econet and to test the very latest version.

only the disc interface hardware, which costs about £100 including VAT, since the Disc Filing System is now combined with the NFS.

The print server machine is fitted with a special ROM -- costing about £50 -- which makes the printer available to any station on the network -- one at a time. The printing takes place "in background", so the print server machine can still be used as a work station. Individual stations can also have their own (local) printer, which need not therefore be available to the network.

This article is an appreciation of Econet, based on seeing a major installation -- that at Felsted School -- in action, and talking to users and to the Econet design engineers at Acorn.

THE LEVEL 1 FILE SERVERS

The first Econet file servers consisted of an Acorn System 3 micro-computer, with at least 16K of RAM, and one single-sided 40-track floppy disc drive of 100K (see Table 1). The Level 1 file server software offers a partitioned file structure, using single-letter directories, with 31 files per surface -- identical to the Acorn (local) DFS (as used later on the Beeb). It is written in BASIC, and hence is relatively slow.

Because of the limited filing system and the low transfer speed, Level 1 file servers usually have only up to about 10 or 20 machines connected. However, this is not a hard limit and up to 40 are possible.

Felsted acquired their System 3 file server in August 1981, and connected three

Atoms to it, each fitted with the Version 1 Network Filing System (NFS) ROM (see Table 2). Later they upgraded it to the equivalent of a System 4 -- by increasing the RAM to 48K and substituting two double-sided 80-track floppy disc drives, totalling 800K. Since September 1981, it has been running Level 2 file server software and the number of machines, now Beebs, connected increased to 20 by December 1982. They are fitted with Version 3 NFS ROMs.

The System 3/4 file server has since been transferred to the Preparatory School -- where it is still working, with five Beebs connected, all located in a single computer room.

This file server -- based on the system -- is no longer offered by Acorn but has been replaced by one based on the single-processor Beeb. It is supplied with a floppy disc filing system -- with either one single-sided 40-track, or two double-sided 80-track disc drives.

THE LEVEL 2 FILE SERVER

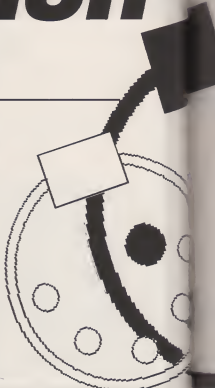
This "Advanced file server" is based on a Beeb with a 6502 Second Processor. The latter is needed to run the larger file server program and to increase the "cache" memory from about 12 to 42K -- to improve the speed of the file transfer. Up to 40 users can be supported, with only short waiting times. This file server uses one or two double-sided 80-track disc drives. They are treated as one or two logical drives (as opposed to four physical surfaces).


The Level 2 file server software is written in machine code

-- and hence runs much faster. With it, the speed of file transfer over Econet is comparable with that to and from a (local) floppy disc -- at up to 8K per second with a floppy disc file server (and up to 16K per second with a Winchester disc file server -- see below).

The Level 2 file server software offers a full hierarchical (or tree) file structure, loosely modelled on the Unix operating system. "Pathnames" describe the path from the "root" directory (\$), which may have up to 255 objects -- either files or further directories themselves -- and so on, until the last directory on that branch of the tree, which contains only files. Since there can be many levels of directories below the root in the pathname, a Level 2 file server allows an almost unlimited number of files per logical disc surface. This is a far cry from the 31 files per actual disc surface of the Level 1 file server!

This file structure is designed to be as similar as possible in appearance and behaviour to the Acorn Advanced DFS (ADFS) -- as used on the Electron with the new Plus 3 disc system, a single Beeb when using the Acorn Winchester, and the new ABC Personal Assistant. The ADFS also allows many levels of directories, each with up to 47 objects (directories or files).





sions) can be selected as the "currently selected directory" — using the *DIR partial pathname command. *CAT then produces a catalogue of the files in just that directory. Any file on another path can still be accessed (again subject to permissions) — e.g. for loading and saving — by using its full pathname.

The file size limit is far above the 12K (by allocation) of the Level 1 file server or the 256K (due to system characteristics) of the Acorn (local) DFS. It is in fact 16MB for Level 2 (and Level 3, see below), though it can be limited by allocation.

The Version 1 and 2 NFSs were for use with Atoms as stations and Version 2 was not officially released, but Version 3 — suitable for both Atoms and Bees — allows a network address from 1 to 127, as well as a station address from 1 to 254. (Networks may be connected by Bridge units — see below.)

With the Level 2 file server and a Version 3.6 or later NFS, it is possible for the same machine to act as both file server and print server — since printing (from the network) is done in the

background, while the file server runs in the foreground.

Well before the Acorn Winchester disc drives became available, Felsted built their own Winchester disc file server. This runs SJ (Spence Jones) file server software (written by Andrew Gordon — formerly a pupil at Felsted) on a Nascom microcomputer with 64K of RAM. It controls an International Memories Inc. (IMI) Winchester disc of 18MB formatted, which they bought in May 1981. Thanks to the bank-switching feature of its Z-80 Central Processor Unit (CPU), the Nascom has a separate cache memory of 48K. The maximum file size is 8MB — as for CP/M. This file server took over the task of supporting all the work stations on the network.

Some 15 machines are fitted with (local) disc interfaces and DFSs (as well as NFSs). One is needed on each file server machine — for loading the file server software and other network tasks. Several machines have larger 20-inch colour monitors as well as normal 12-inch monochrome monitors.

THE LEVEL 3 FILE SERVER

This was announced at Compec last November and uses the same hardware as Level 2 — a Beeb with a 6502 Second Processor. Compared with Level 2, the software offers exactly the same file structure, but uses a real-time clock (rather than manual input) for date stamping of files. It is intended primarily for use with Acorn's own Winchester disc drives, and allows up to 80 users.

The Winchester can be of 10MB, costing £1724 including VAT, or 30MB, costing £2644 including VAT. Up to four such drives (together with up to four logical floppy disc drives) can be connected to one Level 3 file server.

Networks may be linked by a "Bridge" unit, which comprises a 6502 Processor, with 8K of RAM acting as a cache memory. This provides asynchronous, buffered communication between the two networks. However, as well as communicating between machines on the two different networks, it is also possible for users to log onto file servers or output to printer on any linked network. (This is valuable if any should "go down".) Bridge units became available from January 1985 and cost around £230 including VAT.

Since the total number of machines connected to the Felsted system is only about 38, (and will still be only say 43 with the Preparatory School added), it could perfectly well be run as one network. However, it has been divided into two parts, with an Acorn Bridge Unit linking them. The internal network, with 16 machines in the computer room, is some 30m long and operates at a clock frequency of 200kHz, while the External network, with about 12 machines spread throughout the rest of the school, is some 700m long and operates at 100kHz.

A second file server, using an Acorn Winchester disc of 10MB, has been connected to the External network and has

CONTINUED OVER





operated since May 1984. Users are able to be logged on to both Winchester file servers at once, and so have access to the maximum number of files.

There are about six other Bees around the school, which are not connected to the network. One is used by a master for preparing course material and administration in the workshop (although the network is available nearby). Another is in the ground floor flat of one of the masters, who is disabled. It allows him to write letters and prepare course material, using View. (The flat is some distance from the present extent of the network.)

Connecting the Preparatory School network to the main system will enable it to share the central resources much more easily — rather than being limited to transferring floppy discs — as at present. So far it has not been connected to the main network — because it requires getting the cable across a main road. Alternatively, a BT Kilostream link could be used (see below).

MANAGING THE NETWORK

Econet, like any other network, requires a Network Manager — to ensure efficient operation and carry out a number of tasks. Some may be carried out from the user station, while the file server program is running, including: adding and deleting users of the network, creating in the root directory directories in which users can store their own files and saving useful files in the root directory or library, for users to load and run at their stations. Other tasks have to be carried out from the file server machine while it is not running the file server program. These include: preparing new file server discs and backing them up regularly and transferring files from DFS to file server format.

The Network Manager may also be responsible for setting up and commissioning the installation — e.g. adding stations, arranging for extension of the

cable, relocating the clock box (which must be close to the midpoint of the cable) etc. At Felsted, Chris Dawkins has seized every opportunity to run out cables — which has greatly helped to keep costs down.

ECONET COMMANDS

To log on, when you know that you want the default file server and a directory on that file server — e.g. BB, you may type: *I AM BB. Alternatively, if you want another file server and have a private directory, you may type: *I AM 250 FRED RETURN — where 250 is the machine number of the other file server and FRED is your "username". The file server software then puts up a colon and, when you type your password, it does not appear on the screen.

However, most users at Felsted use a !BOOT menu logon option. This is entered by pressing Shift/Break as usual and then offers information on which network you are on and which file server you are using and a two-line area for messages, together with 16 options available on single keys (see below).

Most of the other Econet commands are the same as those available with other read and write filing systems, such as the Acorn (local) Disc Filing System. The *ACCESS command is extended to permit writing to, reading from and deleting of a file separately for the owner and for other Econet users.

Certain users are known as SYSTEM users — who have ac-

cess to the root directory, and therefore all directories on a file server disc. One such user (normally the Network Manager) is present already in the Password file of the file server master disc, but the privilege can also be extended to others.

Other commands are intended for use by supervisors or teachers. Thus *VIEW copies another station's screen to yours, *REMOTE takes over another machine completely and disables its keyboard and *NOTIFY allows a one-line message to be sent to another station. *PROT allows you to stop other users from using *VIEW, *REMOTE or *NOTIFY on your station.

Yet more facilities are available via machine code programming, using "Econet primitives". For example, BROADCAST enables a common message or data to be sent to all logged on stations.

SOFTWARE AT FELSTED

The software available on the Felsted network — direct from the !BOOT menu includes:

- A database of Old Felstedians. This allows information on our former pupil since 1910 to be selected from the 6893 entries in a 1MB file in an average time of three seconds.
- A similar database on present pupils — with some 623 entries. This is used as input to a computer-aided type-setting system, to prepare a printed version each year.
- Separate directories for sub-

jects such as Business Studies and Economics, Chemistry, Geography and Music — each having their own sub-menu, with single-key selection.

- A "directory login", which allows you to log into any of the 120-odd other directories on the system. This is a simple and fast alternative to the standard *I AM FRED-type command, and asks for a password if necessary.

- The Teletext server, from which you can select any "page" on any of the four TV channels. The software — written by Chris Dawkins — also allows subjects such as *NEWS, *SPORTS and *WEATHER to be accessed directly.

- The Microelectronics Education Programme and Computer Park Viewdata systems. These are accessed via a modem and telephone lines.

- A Noticeboard system — which was written by a Felsted pupil. This single Teletext-style Mode 7 screen is also displayed continuously on one large colour monitor and three smaller green-screen monitors in highly visible locations around the school. Two Bees are currently dedicated full-time to this one task, while two more are used part-time (e.g. between lessons). Four separate message areas are available: "Headmaster", "Common Room" (i.e. other staff), "Sports" and "General". After entering appropriate passwords, any machine on the network may be used to edit these files, which are used to update the screen every minute.

- The "Converse" program — which was also written by a Felsted pupil. It allows up to

seven machines to communicate all at once. Any key depression on any station is BROADCAST by the program and each screen is divided into seven three-line areas — one for each machine. It thus provides a useful conferencing facility. As with the Teletext server, Converse is only possible on a network which — like Econet — permits machine to machine communication via open "channels".

● A workshop material stock control system — also menu-driven.

Felsted also uses an (acoustic) modem — for accessing Prestel and for (external) electronic mail via BT Gold (Mailbox No. 81:FL5001).

The Beeb Operating System makes it very easy to add utilities which extend the NFS. These may be called by * filename *. One such is called *PUTGET and creates a buffer in pages 9, A and C — to enable the transmission of files in 128 byte blocks, rather than character-by-character.

SIDEWAYS ROM/RAM PROGRAMS

Acorn do not offer Sideways

RAM boards for the Beeb, which would allow ROM software to be downloaded from a network file server (or from a local disc drive). However, many sideways ROM extension boards offer one 16K bank of sideways RAM, while Sideways RAM-only boards are available from several suppliers — e.g. 1 x 16K from Hybrid Memory Systems, 2 x 16K from Opus Supplies and 1, 2, 8 or 16 x 16K from Solidisk Technology Ltd.

Many software houses actively discourage such downloading for reasons of copyright. The solution currently offered by Acornsoft to multiple (e.g. network) users is substantial discounts on ROM software when purchased in bulk — e.g. 50 per cent on quantities of 10 or more.

The alternative approach is for software houses to grant or sell a "site licence" — for which there are plenty of precedents for mini-computers and mainframes. Working with other schools, Felsted has reached agreement with some software houses (including Computer Concepts for Wordwise and other ROM products).

The Felsted machines are used extensively for word processing — mostly with Wordwise, but one using View. A vast

amount of written material is prepared in this way.

EXPERIENCE WITH ECONET

As Chris Dawkins points out, while 40 independent machines might each have access to 100 files, each of the networked machines has access to over 2000 files, and there need be no duplication of these. Moreover, with suitable software, single facilities such as a Teletext Adaptor and a Telephone Server (a Beeb dedicated to a telephone modem) can be shared by all 40 machines.

Clearly, several of these programs and facilities would be equally useful in commerce and industry.

The Felsted network file servers normally operate 24 hours a day, seven days a week, year round — including holidays. Reliability has been very good overall — especially when allowance is made for the fact that some parts (the Nascom-controlled IMI Winchester file server) have been built at Felsted, while others (the Acorn Winchester and Bridge Unit) are prototypes, supplied before their official launch.

The number of Econet

systems installed worldwide is over 3000 to date. Most are in the U.K., but they are also to be found in Australia, Germany, India and the U.S.A.

FURTHER ECONET DEVELOPMENTS

It will be possible to use Electrons as work stations in the near future. To provide the Econet interface, they will require Plus 2 add-ons — which have yet to become available. However, they promise to be even less costly than those based on Beebs, while still having proper moving key-switch, typewriter quality keyboards and 80-column display modes — all of which are essential for business use.

In addition, the new Acorn Business Computers are all to be fitted with Econet interfaces as standard. Part of the reason for adopting the ADFS for the Electrons and ABCs is so that there is maximum consistency in concepts and practice between the local disc filing system and the network filing system.

Networks can be joined together with Bridge units, as at Felsted. Acorn themselves have about ten — eight at Cherry Hinton and two in the centre of Cambridge. However, by having the two halves of a bridge unit at either end of a BT "Kilostream" link, all the stations on all the networks can intercommunicate. Thus, as well as extending locally, any Econet system may connect between two or more widely separated sites.

Although there may be a great many machines on such a multiple network system — and even more users than there are machines — the Econet Level 2 and 3 software can handle them. For example, Acorn themselves have around 1000 users — all with their own passwords. These are all held in a single file "PASSWORDS" in the "root" directory, alongside several group directories — each containing the personal directories of up to 255 users.

CONTINUED OVER



POSSIBLE FUTURE DEVELOPMENTS

● **Electronic Mail.** The present one-line message issued with *NOTIFY can only be received by a station that is both switched on and logged on. However, electronic mail could be delivered into a user's "mail box" file on the file server — even when their station was switched off. Acorn have not yet released any electronic mail software, but it is known to be under development.

● **CPU servers.** This is a concept familiar to Acorn, since it works like a normal Beeb and Second Processor. Thus the user's workstation provides the Input/Output processor, which uses the CPU server to provide greatly enhanced computing power. Once again, the great virtue of accessing this over a network is that the resource may be shared between many users.

Simple, single-tasking is possible with all the Second Processors, with the present software. Some of the "Second Processors" (e.g. the 32016 and 80286) can support multi-tasking — but the software needs modifying before this will be possible

over Econet. Again, no product has yet been released, but it is known to be under development.

● **Optical discs** will have storage capacities measured in 100s or 1000s of Megabytes — i.e. 100 to 1000 times as much as the largest floppy discs or 10 to 100 times as much as Winchester discs. Initially they will be read-only, but this is ideal for many applications — where rapid access is required to large volumes of semi-permanent data or text.

Again, the cost and capacity of such resources means that shared access via a network makes much more sense. Acorn Video already offer systems for the interactive control of optical video discs. This has yet to be extended to optical data discs and access via Econet.

CONCLUSIONS

Econet has been designed by Acorn to allow their computers — such as the BBC Micro — to share floppy and Winchester disc drives, printers, teletext adaptors and modems (for on-line databases and (external) electronic mail). The cable technology chosen allows file transfer at speeds that are entirely adequate, while keeping the cost to a very low level, compared with other local area networks.

Also, while you do not have to pay for the Econet interface hardware until you require it, full provision is made in the standard cassette Beeb — in both the design and the physical provision of sockets in the main board. The same approach is used for the local Disc Filing System, which may also — but need not — be fitted to work station machines.

However, with its capability of up to 254 work stations per network, (compared with only 16, 32 or 64 on others) and for multiple linked networks, Econet has far greater potential for connecting all the work stations in a company or school — rather than just all those in a department or class.

With over 3000 installations worldwide since the launch in November 1980, Econet may well have the largest user base of any local area network. Moreover, as demonstrated at Felsted, both performance and reliability have been good.

Very soon it will also be possible to use Electronics and ABCs as work stations on Econet networks.

Further ahead, Econet offers the prospects of (internal) electronic mail over single or multiple-site networks and the sharing of CPUs of much higher computing power and optical

discs of very large storage capacity.

I am grateful for the assistance that I have received in preparing this article from Mr Chris Dawkins at Felsted and from the Econet design engineers at Acorn.

FELSTED SCHOOL

The school was founded in 1564 and moved to the present site (nearby) in 1877. It has some 623 pupils — made up of 150 boys in the Preparatory School, 417 boys in the Senior School and 56 girls in the Sixth Form.

All third form pupils receive an introductory course on computing — of one and a quarter hours a week for five or six weeks. There is no formal instruction of fourth and fifth form pupils but those in the sixth form can opt for a two-year course leading to either "O" or "A" Level Computing. (Chris Dawkins is the (almost) full time teacher.)

All pupils can also use computers in many other lessons including business studies and economics, chemistry, geography, mathematics, music and workshops.

Table 1 — Econet File Servers

Software	Hardware		Processors				Disc Drives	
			Systems		BBC's		Floppy	Hard
	3	4	5	Single	2nd Proc.			
Level 1 (BASIC)	*	*	*	*			Up to 2 (surfaces)	—
Level 2 (m/c code)	—	*	*	—	*		Up to 2 (logical)	—
Level 3 (m/c code)	—	—	—	—	*		Up to 4 & Up to 4 (logical)	

Table 2 — Econet Work Stations

Software	Hardware	Atoms	BBCs
NFS Version 1		*	—
NFS Version 2		*	—
NFS Version 3		*	*

PRINTERS

DOT MATRIX

All printers have centronic parallel interface unless otherwise stated. All printers have hi-res dot addressable graphic mode. Please send SAE for full details.

EPSON

FX80 160CPS 10" wide friction & pin feed	£347 + VAT £399
FX100 160CPS 15" wide friction & tractor feed	£499 + VAT £574
RX80 F/T 100CPS 10" wide friction & tractor feed	£239 + VAT £275
RX80 100CPS 10" wide tractor feed	£199 + VAT £229
RX100 F/T 100CPS friction & tractor feed	£385 + VAT £443
8143 RS 232 Interface for FX and RX printers	£39 + VAT £45
8148 RS 232 Interface with 2K buffer x on x off	£60 + VAT £69
Ribbon Cartridge for RX80 FX80 & MX80	£5 + VAT £6
Ribbon Cartridge for FX100 & MX100	£7 + VAT £8

MP165

165CPS 10" carriage friction and tractor feed	£260 + VAT £299
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SEIKOSHA

BP 420 designed for the business world, 420CPS in draft mode, 110CPS in NLO mode.	£1095 + VAT £1259
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SMITH

CORONA

Fastest 80: 80 col, 80CPS. Friction feed standard	£149 + VAT £171
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TAXAN KAGA

160CPS 10" wide 27CPS NLO 24 x 16 matrix	£269 + VAT £310
160CPS 15" wide 27CPS NLO 24 x 16 matrix	£390 + VAT £449

CANON

PW1080A
160CPS NLO
mode, 27CPS, 10"
wide friction &
tractor feed
£299 + VAT £344

PW1156A
160CPS NLO
mode, 15" wide
friction & tractor
feed
£399 + VAT £459



COLOUR PRINTERS

Seikosha GP700A 7 colour 50CPS printer	£299 + VAT £344
Canon PJ1080A 7 colour 40CPS ink jet printer	£433 + VAT £499

DAISYWHEEL

JUKI 6100/I PRINT

20 CPS Bi-Directional Logic seeking 10 12 15 CP1 + PS spacing 2K buffer best selling Daisywheel	£324 + VAT £373
Singer sheet feeder unit	£182 + VAT £209
Tractor Unit	£95 + VAT £109
RS 232 Interface	£52 + VAT £59
Spare Daisywheel	£14 + VAT £16

BROTHER HR-15

13 CPS Bi-directional 10, 12, 15 CP1 + PS	£340 + VAT £399
Keyboard Unit	£139 + VAT £159
Single Sheet Feeder Unit	£217 + VAT £249
Tractor Unit	£95 + VAT £109

QUENDATA

20 CPS Unidirectional 10 12 15 CP1	£239 + VAT £275
------------------------------------	-----------------

All our printers have 1 year warranty

MONITORS

PHILIPS

7001 High Res Green Screen with sound input £55 + VAT £75

GM1211

GM1211 18 MHz High Res. Monochrome Monitor with tilt and swivel stand available in green or amber etched antiglare screen (please specify colour) £96 + VAT £99

SANYO

DM8112 12" Green screen 18MHz Hi Res £96 + VAT £99

DM8112 Hi Res Green Screen with tilt stand £109 + VAT £126

MICROVITEC CUB

1431 MS 14" RGB Normal Res Colour £173 + VAT £199

1451 MS 14" RGB Medium Res Colour £251 + VAT £280

1441 MS 14" RGB High Res Colour £417 + VAT £479

SANYO COLOUR

Sid Res 14" £179 + VAT £206

Med Res 14" £299 + VAT £344

Hi Res 14" £449 + VAT £517

MICROVITEC FOR QL

1451 14" Medium Res Colour

Specialty designed for Sinclair QL

£239 + VAT £275

ACORN R

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SPECIAL

CM 3125

colour monitor



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including free monitor stand



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GROUP

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DISC

100% BBC COMPATIBLE MITSUBISHI AND
TEAC SLIMLINE DISK DRIVES



These drives are supplied ready cased with all the necessary cables formatting program and User Guide. There are some very useful utilities included on formatting disc e.g.

- * DISASSEMBLER: This is £502 machine code disassembler
- * DUP: To copy and rename a file on disc
- * FORMAT: Formatting program for 40 & 80 tracks
- * FREE: This utility provides a disk usage analysis
- * MDUMP: Enables you to display and modify any part of BBC memory
- * MERGE: Merge a number of text files into one file
- * RELOCATE: Downloads a basic program to &E00
- * SDUMP: Screen dump for EPSON in all graphic modes
- * VERIFY: Verifies every sector on a disk
- * MENU: A flexible menu program

N PRODUCTS

Microcomputer Model B	£299 + VAT	£344
Mod B - disk interface	£369 + VAT	£425
Mod B - Econet interface	£349 + VAT	£401
Mod B - disk and Econet interfaces	£409 + VAT	£471
Compatible 100K disk drive	£112 + VAT	£129
Compatible dual 800K disk drive	£312 + VAT	£359
280	£347 + VAT	£399
5502 Second Processor	£173 + VAT	£199
Bit stick	£327 + VAT	£375
IEEE interface	£282 + VAT	£325
Electron plus 1 interface	£52 + VAT	£60
Postel Adaptor	£115 + VAT	£132
Telex receiver (Aug)	£196 + VAT	£225
Cassette recorder and lead	£30 + VAT	£35
Interface kit (free fitting)	£103 + VAT	£118
4 to 16M B upgrade kit	£70 + VAT	£80
Charge for A to B upgrade kit	£20 + VAT	£23
Memory upgrade kit	£30 + VAT	£34
Games paddles	£17 + VAT	£19
User Guide	£12	
Advanced User Guide	£12.95	
User Guide	£ 7.50	
Net interface (free fitting)	£60 + VAT	£69
Net interface (free fitting)	£47 + VAT	£54
disk manual - formatting disk	£30 + VAT	£34
Net printer cable	£10 + VAT	£11
Word processor (view)	£52 + VAT	£59

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TECHNICAL SUPPORT	ALAN LAFFOLEY	207
ACCOUNTS	JULIE AMBLER	211
LIBRARY REQUEST	JOHN MAULE	201

ORDERING INFORMATION

We accept official orders from UK Government and Education establishments. Carriage is £2.50 + VAT (UK only) for normal orders. If express delivery is required please add £3.00 + VAT per order. We accept telephone orders on Barclay and Access card (0279) 443521 (10 lines), all cheques made payable to AKHTER INSTRUMENTS.

N.B. All prices are subject to change without notice and are rounded up to the nearest pound

OPENING HOURS: MON-FRI 9am-6.30pm, SAT 10am-5pm. We welcome callers, no parking problems.

DRIVES

Single drive 100K 40 trks single sided	£86 + VAT	£99
Dual drive 200K 40 trks single sided	£164 + VAT	£189
Single drive 200K 40 trks double sided	£121 + VAT	£139
Dual drive 400K 40 trks double sided	£239 + VAT	£275
Single drive 400K 80 trks double sided	£152 + VAT	£175
Single drive 400K 40 80 trks switchable DS	£155 + VAT	£179
Dual drive 400K + PSU + built-in monitor stand	£260 + VAT	£299
Dual drive 800K 80 trks double sided	£303 + VAT	£349
Dual drive 800K 40 80 trks switchable DS	£312 + VAT	£359
Dual drive 800K 40 80 trks + PSU + built in monitor stand	£373 + VAT	£429

All above drives are low power slimline (0.3 A typ at +12v and 0.4 at +5v per drive) Normally extra power supply is not required. The BBC Computer power supply is designed to drive to low power drive (IT IS NOT DESIGNED TO DRIVE INTERNAL ROM BOARD)

SS DD diskettes (10 Box) £18 + VAT £20

DS DD diskettes (10 Box) £23 + VAT £26

BUSINESS SYSTEMS

COMPLETE BUSINESS PACKAGE

This system is based on 16 Bit 8088 Processor 128K RAM, 2X730K Floppy Disc Drives, High Res Monitor, fast (160cps) Dot Matrix Printer, Wordstar Wordprocessor, Calstar Spreadsheet Program, complete integrated Accounts package consisting of Sales Ledger, Purchase Ledger, Nominal Ledger, Invoicing, Stock Control, Payroll and mailing list. Complete turnkey system at an unbelievable price. Delivered Only £1495 + VAT £1719. Delivered and installed plus 1 day training £1595 + VAT £1834



SANYO PROFESSIONAL COMPUTER

SANYO 555
16 Bit Micro, 256K Ram, double 160K disc drives, MSDOS Operating System, free Green Monitor, free software Calstar, infastar, Datastar etc £999 + VAT = £1149

SANYO 555-360X
As 555 but with 2 x 360K Drives £1099 + VAT = £1264

SANYO 555 800X
As 555 but with 2 x 800K Drives £1199 + VAT = £1379

SANYO 555 10MX
As 555 but with MSDOS 2.11 Operating System and a single 10 Megabyte hard disc and 360K floppy back up. £2195 + VAT = £2525

SANYO 550
16 Bit Micro, 256K Ram, Built in full colour graphics, MSDOS Operating System, Single 16K disc and free Monitor, free software including Wordstar & Calstar £749 + VAT = £862

SANYO 550-IX
As above but with dual drives 2 x 160K £799 + VAT = £919

SANYO 550-360X
As 550 but with dual drives 2 x 360K £899 + VAT = £1034

SANYO 550-800X
As 550 but with dual drives 2 x 800K £999 + VAT = £1149

SANYO 550-10MX
As 550 but with MSDOS 2.11 Operating System and a single 10 Megabyte hard disc and 360K floppy back up. £1995 + VAT = £2295

APRICOT PC
"Portable Executive Computer" 16 Bit Micro, 256K RAM up to 144 megabytes floppy disk storage 3 1/2" Sony discs. Portable brief case styling. Modem with auto dialler (optional) hard disk optional. Vast software library (compatible with Sinus Apricot) with Double Drive, Monitor and Free Printer £1790 + VAT £2059
Apricot with Double Drive, Double & Monitor & Printer £1990 + VAT = £2289
APRICOT XI
As above but with 10MB Winchester Drive and Single 315K Drive plus Superwriter, Supercalc and FREE JUKI 6100 Printer £2995 + VAT £3444

WORD PROCESSING

COMPLETE SYSTEMS FROM £650 + VAT

BBC 1: BBC Micro Model B, View (or Wordwise) Wordprocessor, Quendata 20 CPS Daisywheel Printer, High Res Green Monitor, Cassette Recorder plus 10 cassettes and all the necessary cables £600 + VAT = £747.50

BBC 2: BBC Micro Model B + Disk Interface, View (or Wordwise) Wordprocessor, 100K Disk Drive, High Res Green Monitor, Quendata 20 CPS Daisywheel Printer, 1 Box of Disks and all the necessary cables £749 + VAT = £862.00

BBC 3: Same as System BBC2 but with 400K Drive £825 + VAT = £949.00

BBC 4: Same as System BBC2 but with 400K Drive and JUKI 6100 Daisywheel Printer £925 + VAT = £1064.00

BBC 5: BBC Model B + Disk Interface, View (or Wordwise) Wordprocessor, 800K Dual Disk Drive (Mitsubishi), High Res Green Monitor, JUKI 6100 Daisywheel Printer, 1 Box (10) of 80 Track DS discs and all necessary cables £1095 + VAT = £1260.00

SAN 1: Sanyo MBC 550 Series 16 Bit Microcomputer, 256K RAM, Dual 160K Drives (2 x 160K), High Res Graphics (600 x 200 pixels in 8 colours), JUKI 6100 Daisywheel Printer, High Res Green Monitor, 1 Box of 10 discs, Wordstar Wordprocessor, Calstar spreadsheet and all the necessary cables £1095 + VAT £1260.00

SAN 2: Same as SAN 1 but with Dual 360K Drives (2x360K) £1245 + VAT £1432.00

SAN 3: Same as SAN 1 but with Dual 720K Drives £1295 + VAT £1490.00

SAN 4: Sanyo MBC 555 Series 16 Bit Microcomputer, 256K RAM, Dual 160K Drives (2 x 160K), High Res Graphics (600 x 200 pixels in 8 colours) JUKI 6100 Daisywheel Printer, High Res Green Monitor, 1 Box of 10 discs, Wordprocessor, Calstar spreadsheet, Mailmerge, Spellstar (dictionary), Datastar (database), Repostar plus all the necessary cables £1195 + VAT £1375.00

SAN 5: Same as SAN 4 but with Dual 360K Drives £1295 + VAT £1490.00

SAN 6: Same as SAN 4 but with Dual 730K Drives £1395 + VAT = £1605.00

If you require High Res Colour Monitor instead of High Res Green Monitor in Sanyo Systems please add £320 + VAT = £360 to the above prices.
128K RAM Upgrade for all above Sanyo systems (makes a total of 256K RAM) £150 + VAT = £172.50 including fitting.

Software Charts

GALLUP BBC TOP 20

- | | |
|------------------------------|-------------------|
| 1 Elite | Acornsoft |
| 2 Sabre Wulf | Ultimate |
| 3 Manic Miner | Software Projects |
| 4 Jet Pac | Ultimate |
| 5 3D Grand Prix | Software Invasion |
| 6 Scrabble | Leisure Genius |
| 7 Frak! | Aardvark |
| 8 Mr Ee | Micro Power |
| 9 Football Manager | Addictive |
| 10 Eddie Kidd Jump Challenge | Martech |
| 11 Fortress | Pace |
| 12 Snooker | Visions |
| 13 Twin Kingdom Valley | Bug-Byte |
| 14 Chuckie Egg | A 'n' F Software |
| 15 Aviator | Acornsoft |
| 16 Chess | Acornsoft |
| 17 Challenger | Mastertronic |
| 18 Mine Shaft | Durrell |
| 19 The Hobbit | Melbourne House |
| 20 Hunchback | Ocean |

GALLUP ELECTRON TOP 5

- | | |
|-----------------------------|-------------------|
| 1 Elite | Acornsoft |
| 2 Chess | Acornsoft |
| 3 Micro Olympics | Micro User |
| 4 Gunsmoke | Software Invasion |
| 5 Eddie Kidd Jump Challenge | Martech |

Retail sales for the month ending January 8 1985

Compiled by Gallup for the industry's weekly trade magazine, Computer and Software Retailing. For details contact John Sorrenti, Computer and Software Retailing, Liberty House, 222 Regent Street, London W1R 7DB. 01-434 2131.

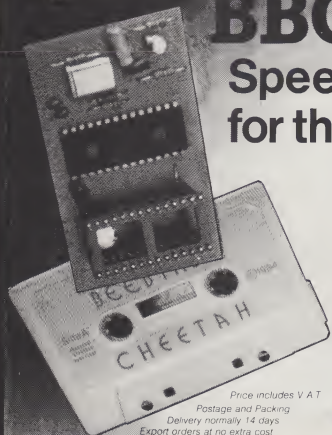


£24.⁹⁵

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Speech Synthesizer for the BBC Computer



Price includes V A T

Postage and Packing

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Export orders at no extra cost

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- Totally unlimited vocabulary is now possible with the revolutionary "SWEET TALKER" Speech Synthesizer for the B.B.C. A or B Microcomputer, any series.

- The CHEETAH "SWEET TALKER" simply plugs into speech socket IC99 within the computer. No soldering, no cutting of tracks, no headaches.

- Based on an allophone system you can easily program any word, sentence or phrase and incorporate speech into your software games.

- Fully tested and guaranteed. Complete with demonstration cassette and full instructions.

Cheetah, products available from branches of

John Menzies  WHSMITH  and Rumbelows

Cheetah

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MICROPULSE 5.25" DISCS FROM MORNTHEN COMPUTERS

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DISC STORAGE

For the BBC Computer



Micropulse 5.25" disc drives cased in high quality steel are fully compatible with the Acorn/BBC disc filing system and contain the highest quality TEAC mechanisms, fitted with head-load solenoids to prevent disc corruption if the computer is switched off while the disc is in the drive. All the Micropulse disc drives are supplied with BBC cables, formatter utility disc and a comprehensive 59 page disc filing system manual.

MP100 Single 40 track (100K) disc drive which is powered by the BBC computer £110.00

MP101 Single 40 track (100K) disc drive with internal power supply £120.00

MP102 Single 40/80 track switched (100K/400K) double-sided drive with internal power supply £189.00

MP200 Dual 40 track (100K) disc drives with internal power supply £239.00

MP800 Dual 80 track (800K) double-sided disc drives with internal power supply £348.00

MP802 Dual 40/80 track switched (2 x 100K/800K) double-sided drives with internal power supply £379.00

Spectrum Disc interface for Micropulse drives with power supply £89.00

3" disc drives (Hitachi/Panasonic standard)

MP11 3" single 40 track (100K on each side of the disc) drive powered by the BBC computer £129.00

MP23 3" dual drives 40 track (100K) (on each side of the disc) powered by the BBC computer £249.00



MP1 Micropulse disc filing system manual with utility disc, as supplied with Micropulse drives £6.95

Micropulse Gold Discs High quality 5.25" floppy discs packed in five packs with labels and tabs.

MP2 Five 40 track single-sided, single density discs £7.50

MP3 Five 80 track double-sided, double density discs £13.50

U.K. customers please add 15% VAT.
Carriage charged at cost.

MICRO PULSE

EXTERNAL ROM BOX

For the BBC Computer



MP8 The external ROM box is now in use with BBC computer systems worldwide. It provides 8 extra ROM sockets including 1 Zero Insertion Force (ZIF) socket for easy changing of ROMs and acts as a buffered physical extension to one of the BBC ROM sockets so NO software modifications are required. The ROM sockets are isolated to avoid ROM interaction problems associated with internal ROM boards, also the external box will not overheat. It is supplied with a removable ribbon cable, and DIL socket which plugs into a BBC ROM socket and leads out at the side being clamped by the top of the computer £49.95

MP8A Spare ROM box cable + connectors £10.00

MP4 Micropulse NIGHTRIDER. A solid steel anti-theft security plinth which can be screwed to the desk in order to deter theft £25.00



MP10 Micropulse parallel printer junction box. Solid state electronic device, allows up to 4 computers to share one printer £99.00

MP21 Micropulse Mirror (on 3" or 40 or 80 track 5.25" disc) cassette-to-disc utility, transfers approx. 10 cassette-based programs to the Mirror disc £9.00

MP25 Micropulse DISC-SMITH. A powerful bit copy utility on 3" or 40 or 80 track 5.25" disc with instructions.

contains:
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The fastest BBC econet file server available. Supports all BASICradom access commands, full length files and full set of econet commands. Extra commands and utilities built-in. Uses ordinary BBC DFS discs. No complex operation or 2nd processor required £99.00

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Retail shop open 9.00 a.m. to 5.30 p.m. Mon. - Sat.
Visa or Access orders: simply phone (0928) 35700. (10 Lines).



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MicroClass

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MAKING TOMORROW'S HISTORY

What do you know about the year 1086? For many readers the answer might well be "very little" until the Domesday book is mentioned. Will 1986 be remembered in 900 years time? The BBC are hoping it will, because they intend producing a second Domesday Book. It'll be in a very different form from the first, as all the information will be stored on two optically-recorded video discs which will hold the equivalent of two sets of Encyclopaedia Britannica.

In December 1984 all the schools in the country were invited to take part in an ambitious project. Those schools who took up the challenge (10,000 were required) will collect information about Britain based on Ordnance Survey maps. With the maps will come a set of discs containing a database questionnaire about the local area, e.g. geography, land use, amenities.

They will be asked to present approximately 20 pages of description and a selection of photographs which represent their area. All this, with the exception of the photographs, will be collected with the help of the schools' microcomputers and will form the basis of the first disc. The second disc will contain information from national data sources on natural resources, transport, social activities, arts and crafts, plus 40,000 pictures from various archives.

Having seen some of the work resulting from the pilot scheme, I must admit I find the project not only ambitious but tremendously exciting. To have the facility to zoom in to a large scale map of any part of the country and convert data to multicolour overlays, and to have data and photographs available on any part of the country sounds like a teacher's dream. So, why is it I have several niggles at the back of my mind?

My first is whether the majority of teachers are ready for the leap forward. In many primary schools the microcomputer is barely out of the box, while comparatively few secondary schools to my knowledge have integrated the computer into their humanities cur-

riculum. While at a first glance the material being collected appears to be somewhat secondary orientated, much of the task of collecting information is likely to be done by primary and middle schools.

Most primary schools are still using cassette recorders with their micros, which is not the easiest way of dealing with data, and many are desperately trying to make money to buy a second micro, a disc drive and/or printer — certainly there's been little or no help from my own Authority! The latest information suggests that the BBC Laser Vision player will cost £900, and schools will require a second processor plus a special Acorn interface.

At a time when many PTAs are being asked for cash to buy essentials such as paper and pencils rather than "the extras", one must wonder where the money's coming from. If schools are not going to be able to benefit from their work because they can't afford the equipment, are they going to be keen to take part?

One magazine recently suggested that my much loved BBC micro should be costing about £180 by present market standards, yet there are minimal discounts available because of its virtual monopoly of the educational market and, of course, its software is incompatible with other machines. The BBC predicts that their Laser Vision player, which is being designed by Phillips Electronics Ltd, will become the accepted standard for education use. Does this really mean that it too will be incompatible with all others?

It's intended that the discs and the player will be available by Michaelmas 1986. Perhaps they will, but will Acorn have the interface ready? Past experience suggests that spring or summer 1987 might be nearer the mark for the first trickle.

My last worry comes back to my colleagues once again. As I sit writing this, the newspaper headline stares up at me — "Bad Teachers Face Pay Penalties". Are we in for another year of discontent and disruption and will it affect the project, or can we "sock it" to Sir Keith, produce a project of which we can be justly proud, and prove that the state of education is far from as black as its head would have everyone believe?

Des Thomas



A TOUCH OF CLASS

Microvitec, household name and highly likely to be the manufacturer of the monitor you use in school, have come up with a sensational product to compliment their range.

We've all read about the use of touch screens in office and industrial computing and you may have seen them at shows. Now the Microvitec Touchtech 501 brings the touch screen to BBC/Microvitec users.

The device clips onto the front of the monitor and tilts it to a position suitable for interaction with the user. It takes five volts of power from the BBC auxiliary power supply and "talks" to the computer via the RS423.

MEP SOFTWARE SUPPORT

Microvitec are launching the Touchtech 501 together with a starter pack of educational software devised by the MEP. The device has great potential as a replacement for QWERTY with young learners and the physically or mentally handicapped. Here is a run down of the software.

Touch gets children started by reporting back grid references to the toucher! **Artist** takes things further with a six foreground colour palette (on white). You paint with your fingers — true digital art. **Artist** is especially designed for pre-readers.

Cubes is what it sounds. **Money** allows children to handle cash without getting their hands dirty, pointing to coins and making up change. This one is most suitable for pre-primary children.

Odd-man is an Ega Beva offering. Picking out the odd letters and drawings helps character recognition.

Simone (a female Belgian Simon!?) is a version of that well known game of flashing colour sequences. A memory test.

Music is a sophisticated developer of new sounds and melodies while **Words** deals in anagrams. The player is restricted to transposing two letters at a time but there are helpful clues. Finally there is a player/player or player/computer version of noughts and crosses, **OXO**.

Touchtech 501 is well documented for users and programmers, an addition of a small BASIC routine should allow many current programs to utilise the touch screen concept. Prices have not been released but, given that Microvitec are offering a product which is likely to sell their monitors as well, it shouldn't be too steep. Details in our next issue. Bet you can't wait to have a go at finger painting.

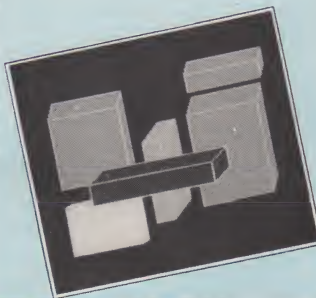
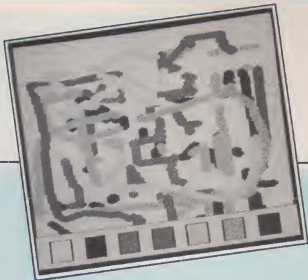
VIDEO VIEWS

Aimed at teachers, parents and advisers, the first two videos in a series from Videotext Educational Publishing are designed to show how the microcomputer can be integrated into the primary classroom of the eighties.

In these two films, *Flowers for the Teacher* and *Magic Without Wizards*, the aim is to dispel some of the myths and prejudices which surround the use of the micro in primary education and to demonstrate that it can have a valuable place working alongside the teacher.

The videos do not attempt to define a "right way" of using computers in the classroom but to point out what is possible. By exploring these possibilities, the films hope to offer a fresh viewpoint from which to examine the role of the micro in the primary school.

Flowers for the Teacher



CONTINUED OVER

documents a class of nine to ten year olds working on a project centred around the software package "The Flowers of Crystal". Based around a fantasy adventure, the work which results is very real, involving activities which range across the whole of the school curriculum. Language, maths, art, craft, drama, science and social studies are integrated into both the project and the working day.

Magic Without Wizards again looks at a school where the staff has enthusiastically accepted the computer into the classroom and made it an integral part of school life. In many schools the micro still exists apart from the main business of teaching. In order to break down this pattern, the school featured in the video has devised a set of criteria for using it: where it can benefit a class activity it will be brought in, but not otherwise. The programme examines a variety of activities that have evolved at the school which involve the computer as a tool — a tool which assists both teacher and children in their work.

Each 30-minute tape is priced at £16.95 plus 95p for postage and packing. For an order form and further information contact Videotext Educational Publishing, Orders Department, Eagle Star House, New North Road, Exeter EX4 4HF (tel: 0392 219309).

COMPUTING THROUGHOUT THE CURRICULUM

Cambridge Micro Software launched their Homerton College educational software range at the beginning of January with a speech by Mr Robert Dunn, Parliamentary Under Secretary of State, Department of Education and Science.

Mr Dunn confirmed Sir Keith Joseph's interest in micro-technology in education since "our future economic well-being is closely linked with the ability of



industry and commerce to make effective use of microelectronics".

Mr Fred Daly, Director of the MEP Homerton College Computing and Curriculum Development Group, emphasised that the software was not designed as a "surrogate teacher" but that it was formulated to enrich the curriculum and provide support for teachers.

Programs to look out for are Tessellations (mathematics) £21, Chemical Collisions (chemistry) £15.95, Lift (physics/applied mathematics) £16.50, Floater (physics/applied mathematics) £16.50, Quelle tete/Jeu des menages (French) £15.95 and Kopfjager/Umziehen (German) £15.95. These prices don't include VAT. All programs are available on BBC B 40 and 80 track discs.

For further information contact Lorna Williams at Cambridge University Press, Publishing Division, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU.

SMILE

Microsmile is a BBC package

containing 30 mathematical programs suitable for both junior and secondary children. The programs range across the spectrum of mathematics and aim to encourage children to think mathematically. Areas covered include number pattern, shape, place value, decimals, co-ordinates, logic, motion geometry, angle, vectors and fractions as well as containing games and puzzles.

Microsmile was devised, developed and classroom tested by practising teachers involved in the ILEA mathematics project SMILE. The package is in full colour with extensive use of the graphic and sound potential of the Model B. It comes on three separate discs with a 24-page booklet. The booklet fully documents the programs, giving an appropriate level of difficulty and suggestions on how they can be used and developed.

Microsmile costs £10.00 for educational establishments in the Capital Region and £15.00 elsewhere. For an order form contact the Centre for Learning Resources, 275 Kennington Lane, London SE11 5QZ (tel: 01-633 5971).

MICRO MATHS

Capital Media are a company who aim to acquire, produce and distribute good educational software, making both programs and documentation available to schools at the lowest possible price commensurate with a high standard of product and service.

Titles available for the BBC are Mathematical Games and Activities, for use by individual children or small groups working without direct supervision, which costs £5.00 for educational establishments in the Capital Region and £6.00 to establishments outside London; and Mathematical Investigations in the Classroom which consists of ten programs where a practical activity is simulated and data collected and tabulated so that children can discover the general rules and develop logical strategies, priced at £6.00 to purchasers from the Capital Region and £8.00 to others.

Capital Media's address is c/o ILECC, John Ruskin Street, London SE5 0PQ.

BBC LOGO

LOGO Software Ltd have published a full Logo for the BBC. Their Logo is the product of two years of development and has been designed to meet the requirements of a Feasibility Study for the Department of Trade and Industry.

LSL LOGO is written in Assembler to be economical and fast working and fitted onto a single 16K Eprom chip. It takes up only one socket on the Model B, leaving the others free for BASIC, word processing, disc filing and other applications.

The package is available to schools and colleges through E J Arnold & Son's School Computer Service and others may order it from LOGO Software Ltd, 316A Richmond Road, Twickenham, Middlesex TW1 2PD at the inclusive price of £67.85. For a free booklet entitled Why Logo write to LSL, Freepost, Twickenham TW1 1BR.

OSPREY!

Bourne Educational Software are launching a competition based on their Osprey! program in conjunction with Boots and the RSPB. The competition will be for the best contributions based on the history of the Osprey and its return to Scotland, set in the wider context of nature conservation and wildlife preservation.

Osprey! has proved to be an ideal stimulus to the understanding of birds and care of wildlife, and also provides ideas for activities away from the computer.

The competition is split into two sections with prizes for both individual and group entries. First prizes in both will be specially commissioned crystal Ospreys, with ten runner up prizes of the RSPB's Book of British Birds.

Entry forms will be enclosed in copies of Osprey! sold in Boots from February 1, and will also be available from any Boots computer department or direct from Bourne Educational Software. Closing date is June 30.

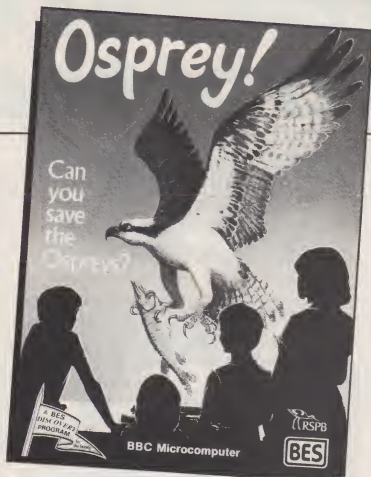
SYSTEM IN SCHOOL

A variety of educational software is now available from System Software as well as a couple of schools administration programs.

Their titles include Write-On, a program to help the development of ideas in the early stages of literacy; Titrations, an aid to the teaching of titration calculations; Survive, a program applicable to humanities, history and social studies and Intervention, an extremely flexible business simulation run by a controller.

Title	Publisher	Price
Datext	Optima	'9.95
Textext Editor	Beebug	'10.00
		'12.00 on disc
Edit 7	Crystalsoft	'5.00
Pixel Plotter	Toad Educational	'14.95
Edfax	Arnold-Wheaton	'30.00

Having our own Mode 7 utilities inspires us to list some of the excellent commercial software available.



Admin titles are being expanded and range from Options, which provides form lists, option lists, subject lists and analysis to Cover, which gives a flexible approach to daily staff cover.

NETWORKING

Schools and colleges will be able to make more effective use of their computer equipment with the introduction of a new low-cost microcomputer network system. Richmead Micro have released Meadnet, a system that allows up to 16 BBC microcomputers to be connected to a single RML 380Z allowing common access to the disc drives and printer of the 380Z.

Before cheaper micros were available, most secondary schools used the 380Z by Research Machines Ltd. However when the BBC was launched it became popular due to its relatively low cost, allowing several computers in a classroom instead of one. The next problem to be faced was how to provide access to expensive peripherals such as disc drives and printers. The answer is a network such as the system Meadnet are providing.

With Meadnet a full implementation of the BBC filing system is provided, which allows loading and saving of both BASIC and machine code programs as well as random access

data file handling. The system is also compatible with View, Wordwise, Edword etc. Programs can be easily transferred from cassette or disc since no user memory is taken up by the system.

Meadnet was designed by a teacher and a software engineer and aims to take into account many of the problems likely to be encountered in a classroom environment. The price is £275 plus £20 for each BBC station.

For further information contact Richmead Micro at 29 Easby Way, Lower Earley, Reading, Berkshire RG6 3XA (tel 0734 665771).

EDWORD EXTENDED

Edword, the educational word processor, has been updated to run with Acorn's new DNFS chip which combines both disc and network handling.

Although Edword is compatible with the disc file facilities of the new chip it cannot be used with the networking facilities. Clwyd Technics Ltd have therefore released Edword 2 on Eprom but will continue to provide the original Rom based Edword for those who want it.

Clwyd Technics are at Unit 4B, Antelope Industrial Estate, Rhymwyn, Near Mold, Clwyd CH7 5JH.

IN BRIEF...

● Back in January we reviewed Archaeology from the Cambridgeshire Software House. Although excellent, the one complaint was that it lacked a sample datafile. This has been resolved because the datafile on Fishbourne is now available from Barry Holmes at Saint Helen's CP School, Bluntham, Cambridgeshire. To obtain a copy write to him enclosing a formatted 40-track disc plus 75p.

● Clwyd Technics have brought out a Break Key Switch. At £5 it's very useful for all of you still using cassette recorders — no longer do users have to worry about pressing that dreaded key and having to start from scratch.



SYMPHONIC

Clive Grace

Turn your BBC into a music making machine. We review Acorn's Music 500 synthesiser and ATPL's symphony music system.

For a long time now the only way to make music on a Micro was to use the internally driven sound chip. It has taken a surprisingly long time for somebody to think of actually making something pleasing to listen to in the form of music, and although the Beeb's ability to manipulate the waveform of a sound to suit a particular envelope and then to reproduce that sound at will has great potential, the problem has been that BASIC is probably the worst language in which to write music.

No matter how structured the code may be, BASIC is still a linear language unlike conventional music notation which is based upon sequential events. The conductor of an orchestra does not flit quickly from player to player, but assigns particular sequences of notes to sections which are needed — he doesn't actually control the music but keeps a series of events in their particular places.

In the past there have been many attempts at standardising a form of computer composition language. But in nearly all cases these have failed to accept that conventional music notation is, in the computer environment, a very illogical means of scoring; its very structure requiring it to look ahead to each successive bar for possible inflection movements or sustain. Of course the composer/player is well aware of the musical rules and has the ability to "scan ahead" in preparation for the next sequence of notes. This is impossible in the computer environment where such haphazard behaviour complicates matters. The possible solutions are to either connect a more friendly form of scoring device to the computer, such as a piano

keyboard, or to completely change the composition language, the latter being far more difficult.

One of the more successful attempts at connecting a piano keyboard to a computer has been with the Synclavier synthesiser, a very expensive system which allows use of the keyboard in real time and stores the musical equivalent elsewhere. This can then be translated (by software) into "conventional" notation, however the system is very limiting as there are things that a Synclavier cannot do. The music it produces is still not as accurate as it might be, for example with chord sequences and unusual time signatures, making music with complex rhythms and microtones such as classical Indian Folk music impossible. But no matter how good a scoring system might be, it still avoids the language problem.

There are now two products which turn the BBC micro into a music making machine. Symphonic is a keyboard/software package that uses the BBC's internal sound chip to make music via a keyboard while Music 500 is a fully professional stereo synthesiser with its own programming language.

ACORN MUSIC 500

Music 500 is essentially a synthesiser extension to the BBC with a programming language to drive the system called AMPLE. It is by far the neatest way of composing and playing music on a computer. The unit itself is housed in a metal BBC beige case which strongly resembles a disc drive unit. It looks very functional

and, with just a switch and a stereo port at the back, the design is very utilitarian. Included with the package is a manual and a cassette containing the various files which make up AMPLE, as well as some demonstration files.

Transferring the files from cassette to disc gave no problems because a TAPEDISC program is supplied as an opening file on side one of the cassette, with clear and simple instructions. The process took no longer than 15 minutes in all.

GETTING STARTED

Connecting the Music 500 unit to the computer involves plugging a decent length of cable into the 1MHz Bus, then connecting a suitable cable to an amplifier (a high quality one is recommended but an ordinary HiFi amplifier will do the job adequately) and connecting some speakers.

That is essentially it as far as hardware goes, pressing Shift-BREAK causes the 'BOOT file to load and in no time at all the AMPLE version message greets you:

AMPLE Model BCE Version 1.0
(C) 1984 Hybrid Technology
%

The "%" prompt is similar to BBC BASIC's ">" prompt. Thankfully the manual includes a testing section which just generates a continuous Middle C, and pressing ESC silences the Music 500 and brings you back to the "%" prompt.

There are a number of demonstration pieces which are good to listen to as well as providing invaluable information as to how certain sounds and pieces

are made up, but this will not be of any interest to the user until multi-part pieces are being written.

ABOUT AMPLE

AMPLE is an acronym for Advanced Music Programming Language and was developed and written by Hybrid Technology alongside their design and development of the Music 500 system. Chris Jordan, one of Hybrid's main men, was responsible for implementing the SOUND commands in BBC BASIC, and his long involvement with computer music makes his grounding very firm indeed.

AMPLE is a true concurrent programming language, one of the first to appear on the BBC micro. Concurrency has been a feature on much larger mainframe systems which allows the user to perform more than one task at a time. Parallel processing is not available on eight bit processors, but with its blindingly fast use of interrupts it really doesn't matter when you consider that 80% of the 6502 is being wasted without interrupts, so concurrency allows more than one task to be performed at once. This need not include just playing music, but also any task that can be typed in. *CATaloging a disc for instance.

AMPLE is a stack orientated language which has great similarities to FORTH in that all numbers are Post-Fix and a stack is available. It can also create words which are then as valid as existing AMPLE commands, but unlike FORTH these are not actually incorporated in the compiler, but in a library of words which are all interacting and immediately available, more in the

OVERTONES



vein of LOGO and its subsets.

The actual notes in music are very simple. "A" stands for a fundamental note which is of a certain pitch, "B" is a little higher, and so on, all the way to "F". AMPLE stores these sequences of notes as letters and can be immediately played by first typing "SOUND SCORE" and then any valid musical note. Therefore typing "ABCDEF G" will give a rising scale through Middle C; the "." symbol is used to determine a "rest" which temporarily causes a rest in the sequence of notes. The pitch can be set by placing a number followed by a colon anywhere in that sequence of notes. Its default is 0: which means that 0:C is Middle C, and a lower case letter states that the note is going down in sequence so that a string like:

1:CcCdDdEeEe

will cause a C to be played followed by a Middle C (going down to Middle C pitch) and so on, resting after d and then playing the E sequence. Incidentally even though "." is not a break, its use at the end of a particular sequence makes it an ideal way of stopping.

The note length can be varied accordingly by using a number followed by a comma, so that:

0: 48.CCD 72.b 24.C 48.DEEF
72.e 24.d 48.c DcBc

will play the national anthem with all the necessary note lengths. A simpler method is by "tying" the notes together by using "=", effectively halving the amount of note length changes. Likewise sharps and flats are represented by a "+" or a "-" sign is used to naturalise the note. To actually create words containing a sequence of notes is even simpler, by enclosing a name in quotes you can create a sequence:

"Frere" [48.0:CDEcDcEcf
96.48 G,eF 96. G
24.GAgf 48.ec
24.GAgf 48.ec
CgC/CgC/.

The Music 500's sound generating hardware is second to none, boasting an impressive 16 sound channels, each with a sampling rate of 46.875 kHz. These can be chained together to add more subtle effects to each sound and all 16 can be used in

this way making a huge 750kHz total sampling rate.

One of the reasons why Music 500 is so versatile in the sounds it can create is its huge array of modulators, allowing the user to control the very sounds that come out.

MODULATION EFFECTS

Ring Modulation is a technique which combines two different signals by mixing two sounds together, which has the effect of making the new signal the sum and the difference of the new sound. The possible sounds are extremely weird and are excellent for atmosphere (Brian Eno and Tangerine Dream are notorious Ring Modulator users). Also the amplitude of the two channels may be altered, making it possible to fade in and out of the effect.

Frequency Modulation is all the rage nowadays and is seen on new synthesizers including Yamaha's DX series. FM combines two tones together making more subtle and commonly "usable" sounds, especially when an OFFSET is included so as to alter the frequency offset (without

pitch) which creates a wavering vibrato effect. Many of the synthesizers today use FM as a means to "fatten up" sounds and to give them a little more ambience, however many recent synthesizers have tended to sound alike due to a lack of ability to set the depth of the FM effect.

White Noise effects are also possible by defining an envelope using the random number generator. I use these sounds mainly on percussion such as "snare" and "cymbal" sounds to represent strong, hard hitting tones or even smooth rolling sounds, increasing the amplitude gently, then quickly dying away at random intervals, suggesting waves crashing on rocks.

Waveforms can also be created by specifying the shape of the waveform, point by point. This seems to be about the easiest and most long-awaited method of getting an envelope into Music 500 via AMPLE. The method is called Geometric Wave Definition or, as the manual calls it, Geometric Synthesis. This method is good at setting up the basic elements of White and Pink noise by writing a random number to the definition:

% "randwave" [128 FOR(RAND? INDEX WG! FOR WGC)

% 5 WMOD randwave

thus "randwave" is created by looping 128 times, each time putting a number in a stack. INDEX simply acts as a counter in the FOR() FOR loop to point to each successive geometric point and is put in by WG! which writes to a Geometric waveform. Finally WGC copies it to the specified waveform which is in this case WAVE number 5. There are 13 in all to be stored at one time, and careful storage of unused procedures can increase that number indefinitely.

ENVELOPES

As with the BBC micro there is the facility to alter the envelopes of a particular signal and these

CONTINUED OVER

can be altered by a number of methods, each of them quite complicated and not really recommended until you at least know something about the nature of envelopes.

Amplitude envelopes are based on a system familiar to BASIC users called ADSR envelopes. The user can design and alter a basic shape with the parameters ATTACK, SUSTAIN, DECAY, RELEASE and the system is good for controlling an overall sound's basic shape. Pitch envelopes vary the sound so that they can create variations within notes, such as a reedy trail to a particular sound to give it a harpsicord type effect, and are controlled by the PITCH AND SHIFT words.

MULTI-PART MUSIC

As AMPLE is a concurrent language it is simple to set up more than one piece to play at a time. The example below shows how to set multiple players and is a typical example of how each task is set up:

```

"play"
0 VOICES 1400 TEMPO      %Reset voices and set tempo
1 EMOD ADSR 1 SUSTAIN 30 %set a ADSR definition
DECAY                    %This piece has 4 Players
4 PLAYERS                %Set nature of ADSR
1 EMOD ADSR 100 SUSTAIN %Left play the theme
1 PLAY1-3 POS trumpet   %middle plays the bass
theme )PLAY              %right plays the melody
2 PLAY1 0 POS bassing bass )PLAY
3 PLAY1 3 POS harping %Player 4 has 3 voices
melody )PLAY             %Just off Stereo Middle
                           %Work from a Score
4 PLAY1 3 VOICES
-1 POS
SCORE
1 VOICE piano
2 VOICE piano
3 VOICE piano chords
)PLAY
GO

```

The play definition is quite a simple one in that the user has to set up where each channel is defined and where in the stereo field the sound is going to be

directed. The play routine calls up the definitions "trumpet", "bassing", "harping" and "piano" which are definitions setting up sounds by any of the possible methods. Armed with its individual sounds, "play" will then look at the "theme", "bass", "melody" and "chords" sections which are the routines actually holding the music in the form of letters and timings.

The language's structure is, I hope, fairly obvious and bears little relationship to FORTH's 1K byte "screens". Each section is EDITable so, instead of listing the whole program, all that is needed is:

```

% "chords" EDIT
% LIST
10. "chords"
20. 12.
25.4 FOR(
30.2 FOR(0:C(EG)//////) FOR
40.2 FOR(0:D(FA)//////) FOR
50.2 FOR(-1:B(DF)//////) FOR % -1: LOWERS OCTAVE
60.2 FOR(-1:A(CE)//////) FOR % NOT NECESSARY BUT CLEAR
70. )FOR
80. )
%

```

```

%Reset voices and set tempo
%set a ADSR definition
%This piece has 4 Players
%Set nature of ADSR
%Left play the theme
%middle plays the bass
%right plays the melody
%Player 4 has 3 voices
%Just off Stereo Middle
%Work from a Score
%Voice 4 plays 3 note Chord
%End the Def for player 4
%Start all the players in seq
%Ends "play" definition

```

and the whole section is LISTED with line numbers included. In order to recompile the routine again the user simply types RUN and the routine will compile line by line quite quickly. Errors are handled nicely by an accurate

and concise error report. There are many reports in AMPLE 1.00 and these are quite the best I've seen in any language. The REPORT command also displays the line in question with a "!" symbol underneath the area in which the compiler considers there is an error. A very nice touch is that the error stack is not corrupted by further keyboard entries, so a mis-spelling of REPORT will not lose that all important message. The report stays within AMPLE until the program has been successfully compiled or a new procedure is attempted.

The structure of AMPLE in a

As well as fast forward, music can be stopped temporarily by using the ON and OFF FREEZE commands.

AMPLE is a big step for and one which will take a lot of knowledge of music and rhythm. For the beginner, probably one of the hardest features of AMPLE is the waveform development time. Normally with such a system it is necessary to draw out the waveform and set about designing it. After some very mixed attempts at making my own envelopes I can only confirm to distraught users that it does eventually click. There are a lot of pitfalls to fall into and a lot of cribbing from the demonstration files was needed before I actually managed to make any headway with this aspect of AMPLE. But, because it sacrifices a little immediate friendliness for one of the most flexible waveform modelling systems around, I am willing to sweat a little in my troubles.

MUSIC 500 KEYBOARD

The most obvious addition to Music 500 is a full sized piano keyboard which when connected to AMPLE allows the programmer to define a word and then play the piece on the keyboard in real time. Hybrid are in the process of finishing their own Music 500 synthesizer keyboard which will span four octaves, and the ATPL symphony keyboard is 100% compatible with Hybrid's keyboard thanks to the fact that the two companies are actually helping each other out in making products compatible and mutually expandable.

THE HYBRID PHILOSOPHY

As with the BBC Microcomputer system, the Music 500 is only a part of the whole. The real centre is not necessarily the synthesiser but the software that drives it. AMPLE is the nearest the computer musician has got to finding a language which is not only machine independent, but

musical sense is straightforward and shows a great deal of forethought. It is possible to set up a whole song still using the bare bones of the "play" routine by calling each section from another one. This makes end listings look something like:

```

"song" intro verse chorus verse
chorus inst chorus verse chorus
"back" b1ntr bvers bchors bvers
intro solo chorus bvers bchors
"drum" roll pat1 pat2 pat1 pat2
pat3 pat2 pat1 pat2

```

If a section of music right at the end of a piece is continually being edited, but the user wants to hear the music with the other instruments, AMPLE allows the user to "fast forward" to any section in the music. This is done by specifying the number of times a particular bar is to be skipped, ie:

```

192 16 * * FAST %skip 16
4/4 bars (as 192 represents a
4/4)

```



can allow itself to have additions made to it without jeopardising the performance of other modules, be they hardware or software. If MIDI was a requirement then the module in AMPLE communicating with the environment would simply be lifted out and replaced with an equivalent. Likewise all the major drum synthesisers and rhythm composers can be controlled under AMPLE and a time code system for synchronising Music 500 with tape machines and other equipment is being developed now.

Many future products coming from Hybrid are hidden away on the manual's cover illustration, including an improved editing facility using windows and an unusual device called "The Baton" which will effectively allow the user to conduct their own piece of music.

GENERAL USAGE

The Music 500 system is a very comprehensive software hardware package which knocks spots off any attempts in the past to make a language fit for both Computer people and Musicians. The language is incredibly easy to use with many helpful error messages. All the error messages are presented in a manner to aid fast debugging and testing of programs. There are facilities to control music by random elements and to nest sequences in loops. Many levels of nested loops can be set up using both the FOR and REP structure which make listings easy to read. The fact that the compiler accepts free form text (ie it doesn't care how the listing is laid out on the screen)

results in easy to read programs which also show just how structured music really can be, which is impossible with ordinary notation.

With the addition of either ATPL's excellent Symphony keyboard or Hybrid's own, Music 500 is more likely to be accepted as a conventional synthesiser by sheer virtue of its huge array of signal processing gates and envelope editors. The sounds possible on Music 500 rival synthesisers ranging from the whole Yamaha DX series (which includes their MSX computer) up to the Prophet range. But, be warned, the chorus sounds like those you hear on Genesis albums (Tony Banks is notorious for using Prophets) are possibly the most complex sounds you'll ever want to program. I would like to see a library of definitions set up to faithfully mimic and improve on current "popular" sounds, after all Acornsoft have started doing this with popular arcade games such as Monsters, Defender and Snapper.

CONCLUSIONS

For the home user Music 500 and AMPLE open up sound possibilities only dreamt of on large £1500-£3000 conventional synthesisers. The fact that manual dexterity with a keyboard is simply not important is a brave step, and one which will take a lot of trouble out of composing. In my mind it is a step in the right direction into the wonderful world of music and at £199.00 for the complete hardware/software package, there are going to be a lot of happy Computer Musicians.

ATPL SYMPHONY KEYBOARD AND SOFTWARE

ATPL are already well established in the field of hardware additions for the Beeb. The general quality of their products is excellent and their "Sidewise" ROM expansion board (reviewed Oct 1984) is generally accepted as the best ROM board available.

ATPL's approach to "Symphony" is completely different from Music 500 in that it uses the internally driven sound chip (76489 chip) which is a simple chip based on three channels where frequency and output volume can be defined plus a pure noise generator.

The whole package consists of a four octave keyboard and some software. Both cassette and disc versions are supported and can use either the Beeb's internal three inch speaker, or can be connected to larger amplifiers with a simple hardware modification. There are many methods available so an approved service centre will know how to do this.

Through the Beeb's speaker the sound is surprisingly good for single notes, although when chords are played the many conflicting harmonics are too much for such a small speaker and colour the tone quite a bit. This is to be expected and gives the sounds an unnatural "reedy" quality so for most of the time I ran Symphony through a Roland Cube, adding some compression to fatten up the sound. A Hifi would do just as well and for many users

this will be the most popular configuration.

THE KEYBOARD

This is a fully professional keyboard which is very nice to feel and it has a similar springiness to synthesisers in the £1500 price bracket. The casing is ruggedly made out of painted metal although the colours may vary between models. At each end are two plastic edges which can be mounted in any standard keyboard enclosure or rack.

The footswitch is used to sustain notes, very much like that of the piano and plugs into a jack socket at the back on the right hand side. On the same side but underneath is the ribbon cable which plugs into the user port. There is no need for additional power as everything is done via this port.

The keyboard is compatible with Music 500 and future releases from Acorn/Hybrid Technology so many users may like to buy symphony for it's keyboard alone, and not the software. Although ATPL have written some software to modify AMPLE to drive Music 500, Hybrid have informed me that it does not affect the performance of AMPLE and is compatible with their other planned products as well, which is good news to all.

THE SYMPHONY SOFTWARE

This is a BASIC/machine code program which can store up to

CONTINUED OVER

Clive Grace has now returned to the studio with Music 500 and Symphony and will report back in a forthcoming issue on how AMPLE fits into the professional music environment.

The results will be made available as an exclusive cassette tape offer to readers of A&B Computing, so you can hear just how good Music 500 sounds!

100 sounds in all. The package is menu-driven and all the menus are written in BASIC so the user can modify them if he wishes. The software is complemented with a thin but readable user manual, in fact their description of the BBC's envelope facilities is so well written somebody should include it in a larger "Sound" work. All the necessary information is well laid out with some clear illustrations, the examples are all drawings rather than printer dumps with shading to highlight the relevant positions on the screen.

The sounds are stored in Banks of 10 function keys. Using the Shift function keys together calls up each bank which contains 10 sounds. These include sounds such as "Harpiscord", "Piano" and "Train", but by far the most pleasing are the Organ sounds, "Pipe Organ" having just the right hollow sound to it. Add a little ambience by putting some reverb (or play the thing in the toilet) and you've got a passable rendition of ye olde. Although the parish church organ sounds for organ are very accurate, the Harpiscord and Piano sounds are definitely suspect, but this is asking too much of humble BBC sound chip. After all it was intended as a general sound device, so we cannot expect the subtleties of a Bosendorfer Grand or even a Wurliitzer organ, but it has a jolly good attempt at it nonetheless.

Some of the sound effects are excellent, their "Whistle" sound is just right for copying trimphones (Middle C is about right) as well as some nice train effects. Weird and esoteric sounds include "Moonbase" and "Onaip" (piano backwards!). In order to get some heavier sounds coming out of the Beeb, sounds which the chip cannot normally achieve, Symphony fattens up the sound by including a carefully controlled noise channel which has its pitch adjusted. This is no mean programming feat so, well done APTL, the effect is very good indeed.

The second and third options include LOADING and SA-

VEing the sound files. These are saved as numbers so that it is impossible to overwrite the synthesiser program, so a file "1" will be saved as "SOUND1" on the disc. Options 4 and 5 exchange and transfer the envelopes from one definition to another, making it possible to store a whole repertoire of sounds at the start and some more "experimental" ones at the back.

Keyboard commands include the " " and " " keys to move in full octaves. If the note is so low that the 76489 cannot handle it, it moves back to the top. There is also a pitch control which varies the key of an instrument. The keyboard is essentially based on the C keys so, by altering the pitch, the Middle C key can sound in B flat making key transposing an easy option. This is still backed up by a fine detuning facility which is the same as a "Bend" key on a synthesiser. This affects all four channels although, unless bassier sounds or percussive/white noise sounds are needed, the fourth (noise) channel is always switched off.

The response is good for a manual type read organ, and fast work is really better achieved by increasing the attack rate on most of the sounds. The organ sounds are effective when used with three note chords but seem to definite sound is needed, which can be achieved by switching the Clarinet and Flute sounds from Monophonic (one note at a time) to Polyphonic (in the Beeb's case three sounds at once).

In all, the Symphony software is good for simple sound and music making and it is fun just playing along with some simple songs. With the prospect of some sequencing software in the future, you can take Symphony a little further than just an average Bontempi sound. The keyboard alone is worth the £135.00 which includes a manual as well as some software (disc or cassette). The important music software is written in machine code for speed and reliability whereas the menus and options are all handle in BASIC. This means that if the user wishes to write some additions to Symphony, it

is simplicity itself.

MUSIC 500 SOFTWARE

ATPL are well aware that producing the only currently available keyboard with a decent action and a wide enough octave span means that many Music 500 users will wish to purchase it and

The Demonstration software once loaded from within AMPLE by:

% "DEMO" LOAD RUN %

will set up some predefined waveforms as well as communicate with the user port. Certain keys affect the sounds that are made and they are:

Shift	f0-f9	Selects the Amplitude Envelope
Ctrl	f0-f9	Selects a Waveform
	f0-f9	Selects a Pitch Envelope
	0-9	Selects a particular rhythm Tempo, or none at all
F		Makes the Tempo faster
S		Slows the Tempo down
>		Up an octave
<		Down one octave
RET		Go to the % Prompt in AMPLE

fit it into their system. Well, thanks to both Hybrid and APTL, this is now possible through some software written in AMPLE which gives the user eight note Polyphony and full control over the envelope definitions, as well as a small rhythm box accompaniment which sounds exactly like the real thing. Of course if you wish to modify the sounds you are welcome to, in fact APTL give full details on how their patch to AMPLE works so the user can call up the same routines in his own programs. This uses CODE, a feature of AMPLE which calls an external machine code routine (or Operating System call). The software is very simple to use and turns the BBC into a full function organ.

AMPMOD is a BASIC/6502 program which modifies the AMPLE language to read from the User Port. Initially the Music 500 keyboard was to run through the 1MHz Bus, but this has now been changed so it will run using the same communications protocol that Symphony does. It simply patches the program by adding a software hook to the "Image" file on your AMPLE backup disc and then finishes: AMPLE is unaffected and you can now drive the keyboard.

The sounds are very good indeed and a wide variety of usable effects can be made (over 1000 to be precise). A maximum of eight notes are available and can faithfully make some extremely accurate organ sounds. By simply *EXECing an ASCII file of another waveform definition (AMPLE has no ability as yet to append files unless *SPOOL-ed etc), your own sounds can be incorporated with few problems. The rhythm accompaniments can be edited as well as changed, so "that rhythm that's been on your mind all day" can now be played to death.

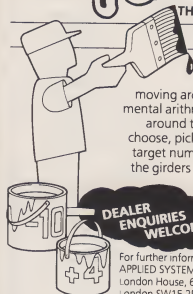
We will all have to wait until Hybrid finish their keyboard storing/scoring addition to AMPLE before we can actually incorporate the Symphony keyboard in the composition side. Still, with APTL's addition and with modification to the synthesiser software, the BBC micro can be a "proper" performance synthesiser.

Number Painter

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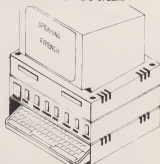


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* As reviewed in this issue.

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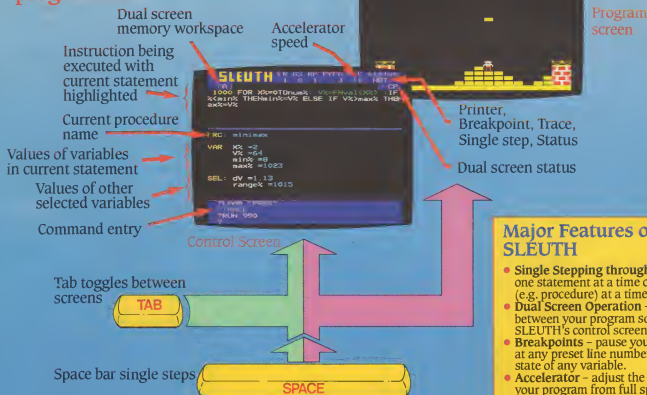
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